Advances in triggering and data acquisition

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Collider Data Analysis Strategies
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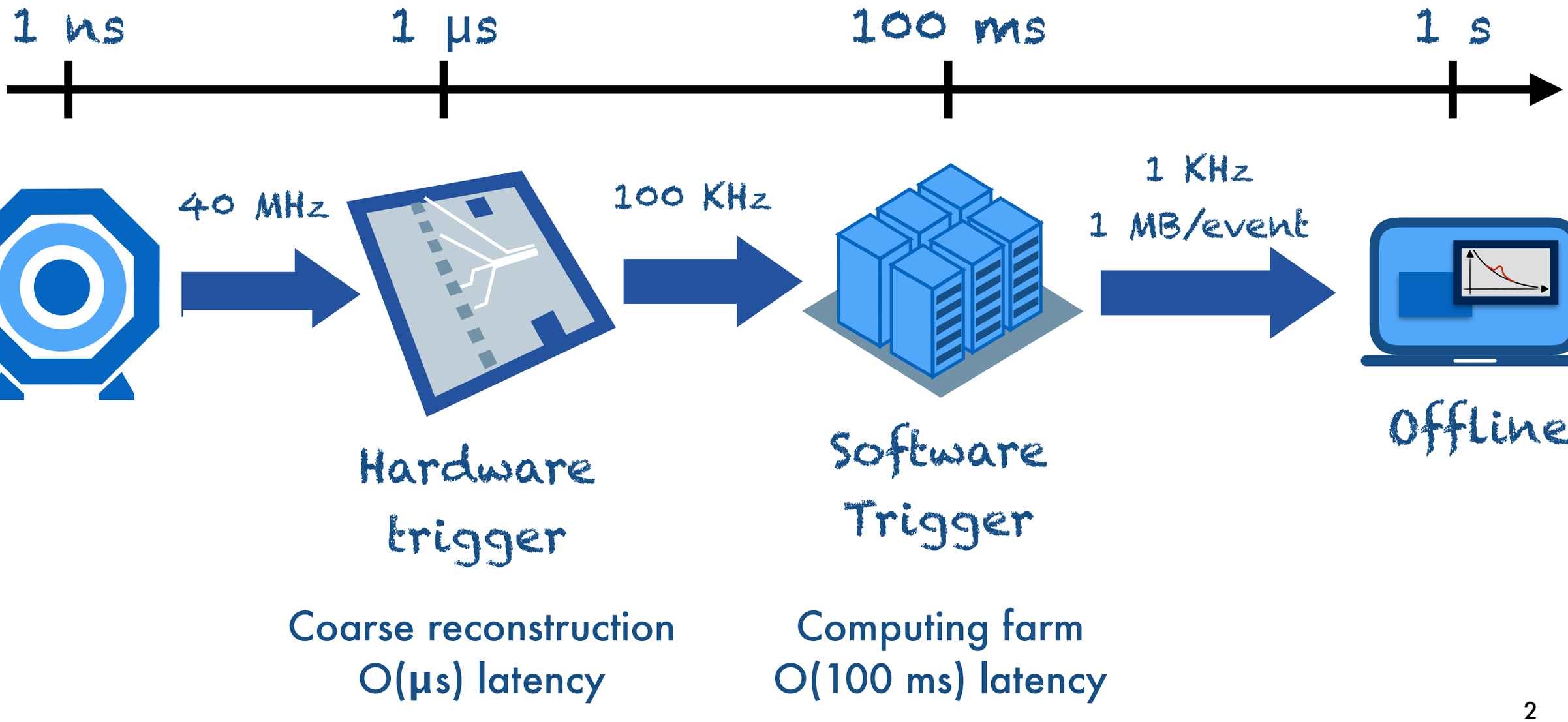
The trigger system @ LHC

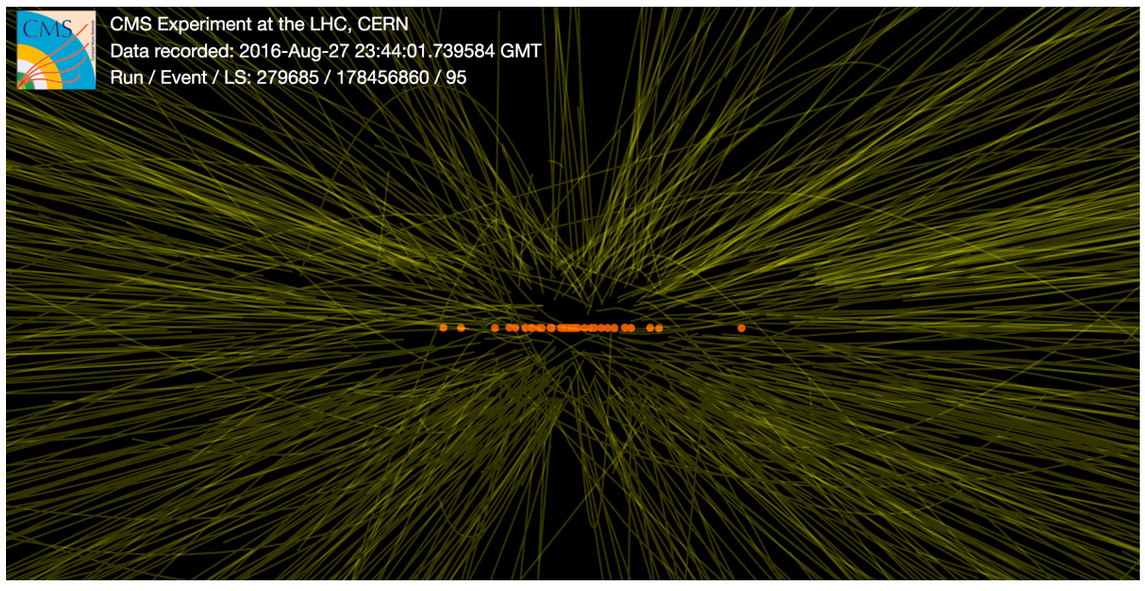
- Experiments at colliders must deal with extreme data rates of O(100) Tb/s
- We must reduce these to manageable levels for offline processing and storage by filtering collision events → triggering



Trigger challenges @ HL-LHC

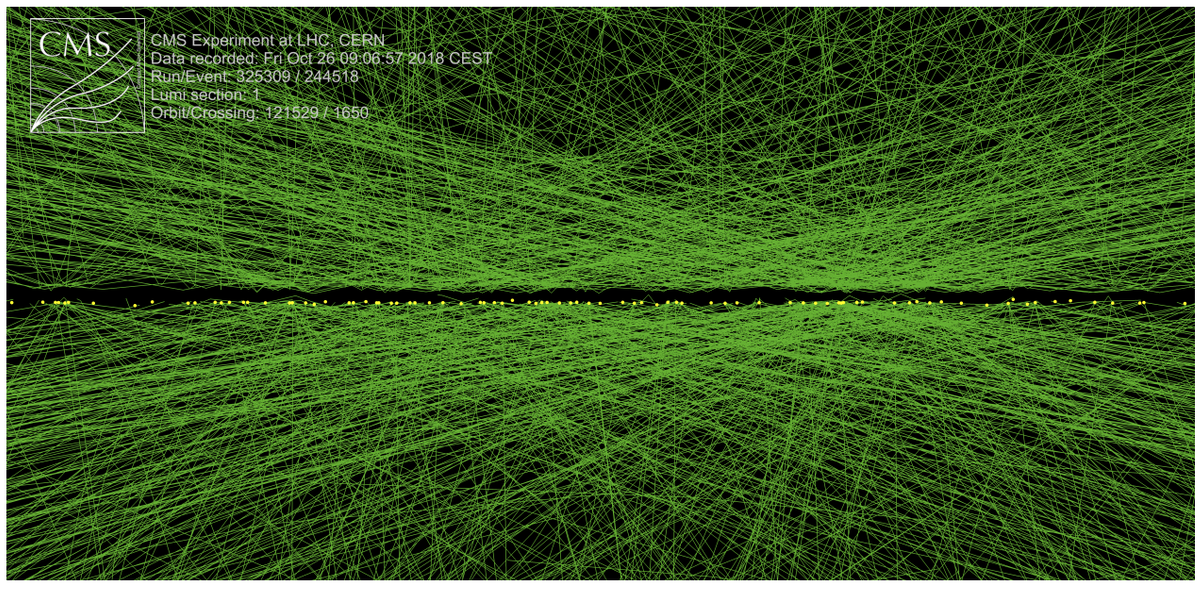
- Untriggered events are lost forever → need very fast and very accurate algorithms
- With higher rates, more pileup, more readout channels
  event data to become more complex at HL-LHC
- A challenge to mantain physics
  → need more sophisticated triggers and DAQ systems

LHC today



40 pp collisions per bunch crossing

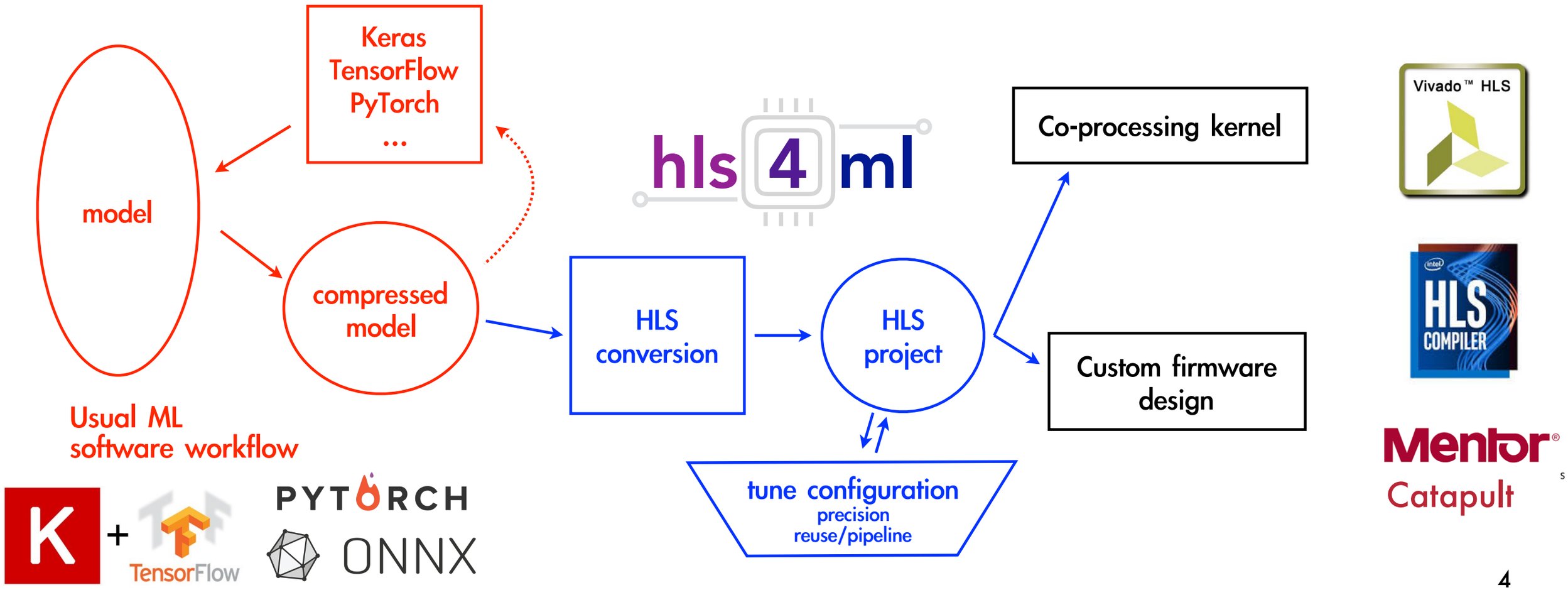
HL-LHC



200 pp collisions per bunch crossing
+ more granular detectors

Advances & opportunities

- **Hardware trigger:**
  - port offline-like algorithms to FPGAs [ex, tracking and particle flow]
  - deploy deep learning, highly parallelizable inference on FPGAs
  - take advantge of new industry tools for compiling more common C/C++ code to hardware language [ex, hls4ml for low latency DL inference]

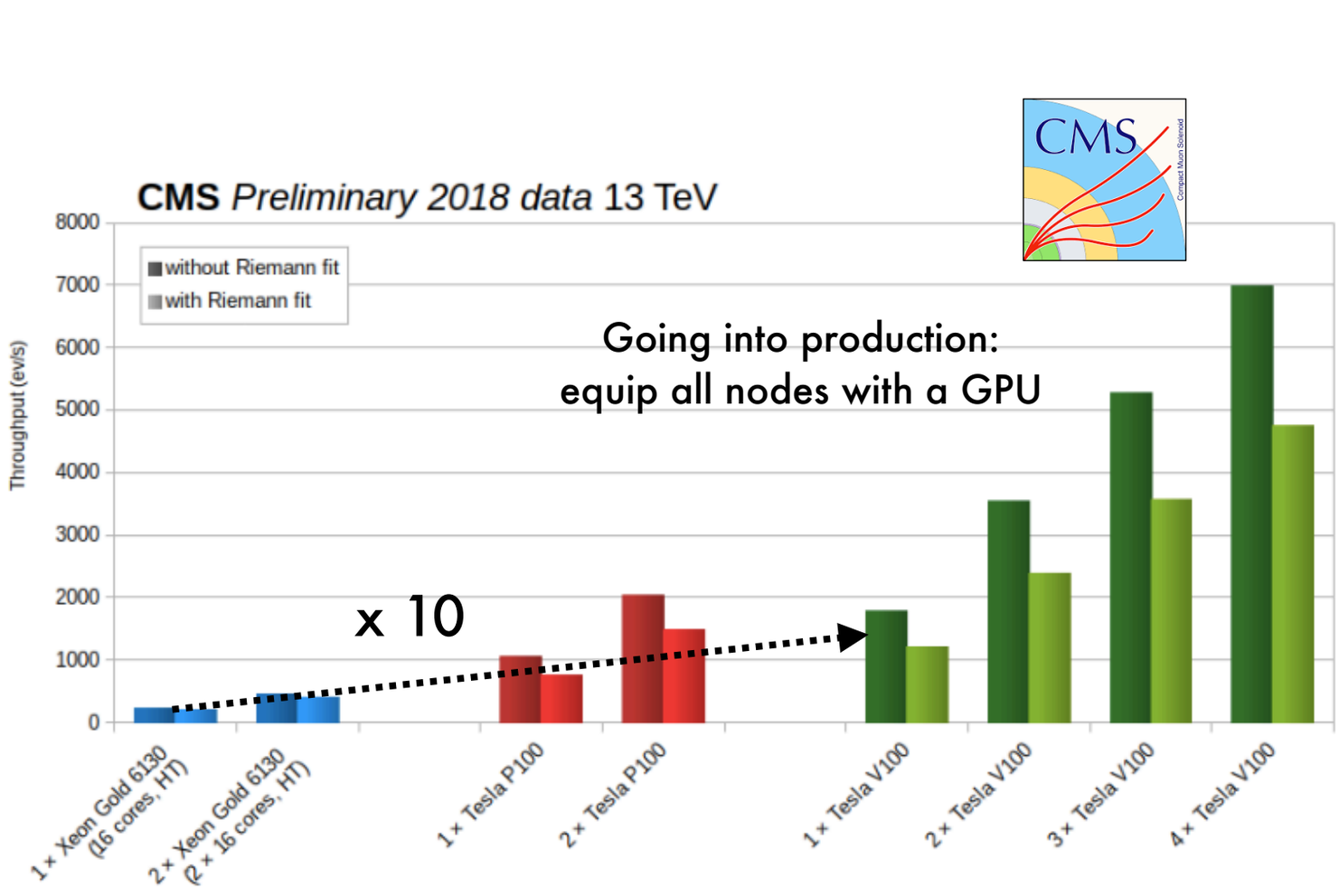


Advances & opportunities

- **Software trigger:**
  - heterogenous computing systems to increase througput at flat cost [*]
  - with GPUs in place deep learning inference could be made very fast (and faster than the standard physics-inspired reconstruction algorithm)

[*] Example for CMS:

today offloading 24% of the online reconstruction to GPUs (pixel tracking, calorimeter reconstruction)

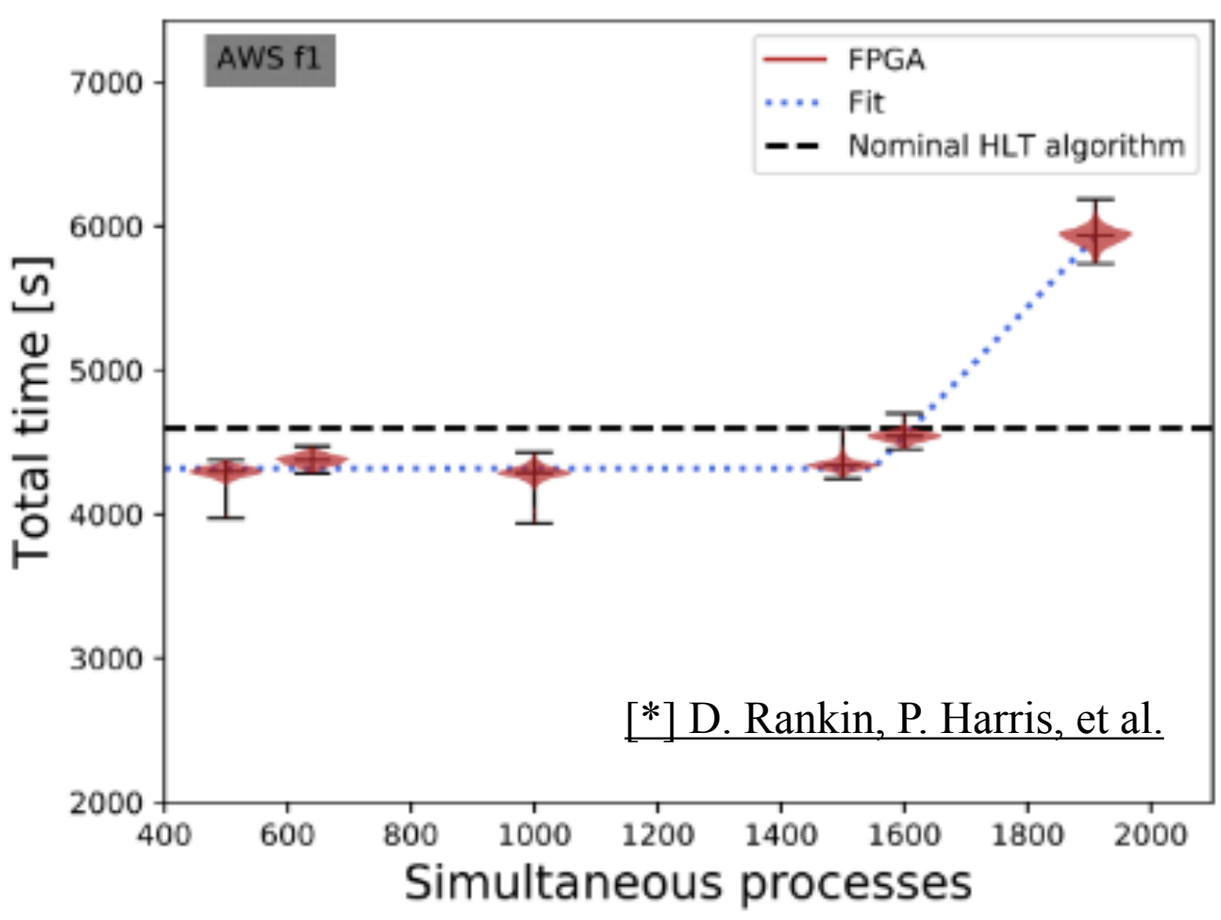


See A. Bocci talk at CHEP19

Advances & opportunities

- **Software trigger:**
  - heterogenous computing systems to increase througput at flat cost
  - with GPUs in place deep learning inference could be made very fast (and faster than the standard physics-inspired reconstruction algorithm)
  - CPU+FPGA system and more exotic processors also being explored with promising results for DL [*]

Thank you!



[*] D. Rankin, P. Harris, et al.